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<b>13. ABSTRACT (Maximum 200 Words)</b> We completed enrollment of subjects on September 30, 2000 for our nested case-control study of the association between magnetic field and breast cancer risk among a group of predominantly African-American and Latino women in Los Angeles County. The research questions remain as follows:  <u>Primary</u> 1.) Is residential exposure to magnetic fields, as assessed by wiring configuration coding in homes occupied over the past 10 years before diagnosis, associated with the risk of breast cancer. Wiring configuration coding is a method that uses data on the types and distances to nearby outdoor electrical wiring to impute magnetic field levels in homes. 2.) Do higher exposures to alternating current (AC) magnetic fields, as assessed by 7 days of measurements, increase a woman's risk of breast cancer.  <u>Secondary</u> 1.) Do particular combinations of the alternating current (AC) magnetic field and the direct current (DC) magnetic field, increase the risk of breast cancer. The AC field results from our use of the 60 Hz electric power supplied by utilities; the DC (or static) field results from the earth's magnetic field but is altered by the environment within residences. This hypothesis was prompted by observations of biologic effects at particular combinations of the AC and DC fields in several experimental systems.				
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## INTRODUCTION

### Primary Specific Aims:

1. One primary specific aim is to determine if residential exposure to magnetic fields, as assessed by wiring configuration coding, is associated with the risk of breast cancer. Wiring configuration coding is a method that uses data on the types and distances to nearby outdoor electrical wiring to impute magnetic field levels in homes. Specifically, we will test whether subjects who have lived over the past 10 years in homes with wiring configurations associated with higher exposure to magnetic fields have an increased risk of breast cancer.
2. Another primary specific aim is to determine whether higher exposures to alternating current (AC) magnetic fields, as assessed by 7 days of measurements, increase a woman's risk of breast cancer. Measurements will include 6 days of measurements in the bedroom of the current residence and 1 day of personal monitoring.

### Secondary Specific Aim:

1. The secondary specific aim is to test the hypothesis that particular combinations of the alternating current (AC) magnetic field and the direct current (DC) magnetic field, increase the risk of breast cancer. The AC field results from our use of the 60 Hz electric power supplied by utilities; the DC (or static) field results from the earth's magnetic field but is altered by the environment within residences. This hypothesis was prompted by observations of biologic effects at particular combinations of the AC and DC fields in several experimental systems. In year two we received supplementary funding from the ARMY to update our exposure assessment protocol to better address this hypothesis. We now use the Multiwave System II to simultaneously make the spot measurements of the AC and DC fields so that we can be sure of their relative orientations.

### Significance:

Major differences in breast cancer rates between low incidence countries in Africa and Asia and high incidence countries in Northern Europe and North America (Parkin 1992), as well as the rise in incidence over time (Devesa et al., 1987), suggest that some correlate of industrialization influences breast cancer risk. Although many factors correlate with industrialization, including changing reproductive patterns, increasing exposure to magnetic fields produced by the electric power system could play a role (Stevens et al., 1992). Support for this conjecture comes from the laboratory in the form of a plausible biologic mechanism linking EMF exposure to enhanced risk of breast cancer (Stevens et al., 1992). Central to the hypothesis are laboratory studies of the effects of magnetic field exposure on pineal function, in particular melatonin production (Kato et al, 1993), and the inhibitory effects of melatonin on mammary carcinogenesis (Hill and Blask, 1988). Melatonin, a hormone crucial to regulation of circadian rhythms, also plays a role in control of the reproductive cycle (Tamarkin et al., 1985). In addition, more recent data suggest that magnetic field exposure, at levels close to those observed in homes, may decrease melatonin's inhibitory action on breast carcinogenesis (Liburdy et al., 1993).

While epidemiologic data are sparse, there is evidence that occupational exposure to magnetic fields, as approximated by job title, is a risk factor for breast cancer in both men (Matanowski et al., 1991; Tynes and Andersen, 1991) and women (Savitz and Loomis, 1994, Coogan et al., 1996). Further, there is data that female breast cancer risk is associated with higher residential exposure as assessed indirectly by wiring configuration coding (Wertheimer and Leeper, 1987)

There are laboratory and theoretical data that suggest that certain combinations of AC (time varying) and DC (static) magnetic fields may have enhanced potential for causing biological effects (Blackman and Most, 1993). These are generally referred to as magnetic-resonance hypotheses. While there are few epidemiologic data suitable for examining these hypotheses in relation to cancer risk, one recent study suggests that combinations of the AC and dc field are associated with the risk of childhood leukemia in Los Angeles (Bowman et al., 1995). Because of this exciting result, we included measurements of dc magnetic field in the home to address secondary aim # 2 above.

#### Methods of approach:

This is a nested case-control study. The base population is a cohort study of African-American and Latino women in Los Angeles County. Exposure assessment is by means of wire configuration coding combined with direct measurements of AC and DC magnetic fields. More detail is found in the Body of this report.

### **BODY OF THE REPORT**

There are essentially no changes in the study methods over that proposed in the original submission with the exception of the fact that we received supplementary funding from the ARMY breast cancer program through the National Action Plan on Breast Cancer. This supplementary funding was to enable us to purchase the Multiwave System II exposure meter for making simultaneous spot measurements of the AC and DC fields to provide a more accurate test of our secondary hypothesis. In this study, we are assessing exposure to magnetic fields in three ways:

1. **Wiring configuration coding**, in which data on the types and distances to nearby outdoor electrical wiring (i.e.: transmission and distribution lines) are used to impute magnetic field levels in all homes in Southern California occupied by subjects in the past 10 years. We are using a protocol developed for an NCI funded study of childhood leukemia which has been extensively tested. This is a modification of the Wertheimer Leeper wiring configuration which has been associated with the risk of childhood cancer in a number of studies (Wertheimer and Leeper, 1979) but has not been well studied in relation to breast cancer. Wire coding involves drawing a map of the type of power lines running within 150 ft of the house and their distance from the house (250 for transmission lines). The wire coding is being done in a blinded fashion a computer algorithm after specified data are abstracted from the map.

2. **Direct recordings of alternating current (AC) magnetic fields** in the home over 7 days using Emdex magnetic field meters (Enertech Consultants, Campbell CA). The meter takes measurement every 120 seconds. The meter is worn by the subject for the first day and then placed at the bedside. After recording, we download the data to a laptop computer, check and then store the data for analysis.
3. **DC (static) magnetic field measurements** at several locations in the home using the Multiwave System II (ERM, State College PA). These are made along with corresponding spot measurements of the AC magnetic field at three locations in the bedroom (2 locations on the bed--where the subjects' head lies and where the chest lies), as well as in the bathroom, kitchen and living room. The use of Multiwave System II, which we were able to purchase thanks to supplementary funding from the ARMY enables these AC and DC spot measurements to be made simultaneously by the same instrument. This way we are certain of their relative orientation which is important to testing the secondary hypothesis.

A questionnaire regarding residential history and sources of magnetic field exposure at home (such as appliances) as well as history of occupational exposure to magnetic fields and exposure to light at night (a potential confounder) is also administered. The questionnaire was based largely on a questionnaire used in a recently completed study of magnetic fields and breast cancer in Seattle (NCI funded). However, we benefited from feedback from those investigators regarding which questions on their questionnaire did work as well as others.

The study is a case-control study nested within a cohort study of risk factors for breast and other cancers among African-Americans and Latinos in Los Angeles County directed by Dr. Brian Henderson . The cohort study is funded by the National Cancer Institute (CA 54281 – Lawrence Kolonel Principal Investigator). The base population for the nested case-control study consists of the cohort of approximately 74,000 women who are predominately Latino and African-American aged 45-74 years who responded to a 26-page mailed questionnaire which includes information on known risk and suspected risk factors for breast cancer and a detailed dietary history. The cohort was recruited from computer files of the Department of Motor Vehicles (for persons under age 65) and the Health Care Financing Administration (for persons over age 65). The nested case-control study of magnetic fields and breast cancer includes all incident cases of female breast cancer diagnosed within the cohort over 4 years. Women with incident breast cancer are identified through the population based tumor registry for Los Angeles County. Controls are a random sample of women in the cohort who do not have breast cancer. The review of first previous annual report expressed concern over the possibility that some of the controls might really have breast cancer. It is possible that a small number of women, were they subject of mammography, might have breast cancer. However, given the low annual incidence of breast cancer among women as a whole in this age group, we would predict that only a handful of women in the group of over 1000 controls will have breast cancer. This is clearly a trivial form of bias. This potential bias is minimized further because we will know whether a

woman previously enrolled as a control is subsequently diagnosed. So, we can use the appropriate analytic techniques from the literature to deal with this handful of subjects. We have just recently expanded the base population to include women who self-report being non-hispanic white in the cohort who were recruited from the neighborhoods which were identified as predominately Latino. The reason is to ensure enrollment of our target number of cases and controls. The study population remains primarily minority women. Cases and controls are contacted to participate in the measurements and questionnaire. Women who chose not to take the time to actively participate in measurements can be included because exposure can be indirectly assessed by wire configuration coding the home occupied at the time of diagnosis. In addition, data on risk factors for breast cancer are available on all subjects from the baseline cohort study questionnaire.

#### Quality control:

Emdex meters and magnetometers are formally factory calibrated every 6 months but we calibrate them weekly at the office using equipment designed by our engineering consultant, William Kaune, and thus would identify any faulty machines (no problems to date). Wire coding is done blind to case or control status. Wire coders were trained by William Kaune and adhere to a standard protocol for drawing maps. The actual wire code is assigned by a computer algorithm to eliminate potential bias. Dr. Kaune has designed a calibration unit for the Multiwaves and we calibrate weekly. We will also send the Multiwaves to the factory for calibration yearly. Quality control for wire code entails having a random sample of wire maps redrawn by an experienced mapper, Bob Workley with Enertech Consultants. He did all wire coding for the large NCI funded study of childhood leukemia published this year. We then compare these maps to those of our study mappers and identify any discrepancies and discuss them while at the location. This will be repeated every 6 months. To date we have had excellent concordance. The only minor discrepancies have involved the parameter of thick versus thin wires which is a known weakness of the original Wertheimer Leeper wire code as it is subjective. However, we also use the modified Kaune code which does not use this parameter.

### **STUDY PROGRESS AND CONCLUSION.**

The study is jointly funded by NIEHS (grant number 5 RO1 ES 06912 ending 8/31/01) which funded the study initially as a five year study. In contrast, the Army funded the study for four years only. We have needed additional time to complete the study. This is primarily because this is a nested case-control study based within a larger cohort study (funded by the National Cancer Institute, CA 54281 – Lawrence Kolonel Principal Investigator). This is a major strength of the study, compared with usual case-control studies, in that the base population is well defined and selection bias is minimized. It has also meant that we were entirely dependent on the flow of cases from the larger cohort. Initially, the number of cases was slightly less than predicted. In addition, we were further limited by the fact that these breast cancer cases were being enrolled first in another investigation by the cohort study investigators and we were only allowed to contact cases after they have completed the other study. Thus we continued subject enrollment

through September 2000 to meet our target. We have drawn wire maps for at least one residence on 758 cases and 702 controls, measurements have been made on a substantial proportion willing to participate in this more extensive phase of the study. We have complete measurement protocol on 342 cases and 284 controls and partial information on 215 cases and 134 controls. Subject enrollment ended September 30, 2000.

As I am sure that you know, once data collection is complete, several months are required for completion of data entry, checking and preparation of the dataset for final analysis. Thus we are not in a position to perform case-control analyses. Although we planned ahead and made good progress in completing data entry as the study has progressed, there still remains a lot of work to be done before manuscripts can be written. For these reasons, we have requested an additional no-cost year from the Army, extending this grant through 9/30/01, which will help us to complete the scope of work for this grant and ensure that we can prepare final results and manuscripts from the data. NIEHS has already granted a second no-cost extension through 8/31/01.



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